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ADOPTION OF CLIMATE RESILIENT TECHNOLOGIES LEADING TO SUSTAINABLE FOOD SECURITY

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ABSTRACT

Climate change and its variability are emerging as the major challenges influencing the performance of Indian agriculture. Long-term changes in shifting weather patterns like fluctuation of temperature, variability in rainfall pattern and rising of sea levels resulted in changing climate, which are now under threat to agriculture and allied activities. Over the years climate change adversely affect the crop yield up to 5 to 9 percent in NICRA operated villages. Unseasonal rainfall affects the crop during critical stage of crop growth or during harvesting of crops. Loss during harvesting of paddy was 23-29 per cent during kharif and summer. Delay in monsoon also affects the crop vegetative growth and crop yield.

To address these issues, ICAR has launched a major network project, National Innovations on Climate Resilient Agriculture (NICRA), during 2010-11 in 100 vulnerable districts across India to undertake strategic research. While studying the impact of climate resilient technologies in agriculture in rain fed and irrigated areas of different agro-ecosystem, most of the technologies are well accepted by farming communities in two NICRA adopted villages. As a result paddy yield significantly increased up to 32 per cent followed by 30 per cent vegetables yield of brinjal, pointed gourd, chilli and 20 per cent yield in pulses was reported by Krishi Vigyan Kendra (KVK), Subarnapur and KVK, Kendrapara of Odisha (Annual Report 2012, 2013 & 2014). It led to 98 per cent increase in income and considerable reduction in livestock and fish mortality. Large portion of uncultivated land is brought to cultivation in Rabi and summer season in Kendrapara district. Water storage capacity of Water Harvesting Structure, Ponds and Wells are enhanced the water table up to 3-5 ft over a period of three years.A logical roadmap to climate resilient agriculture requires integrated approach on adoption of climate resilient technologies, participation of farmers, partnership and support of political and service organizations.

KEYWORDS: Climate Change; Climate Resilient Technologies; Adoption of Climate Resilient Technologies

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INTRODUCTION

Agriculture not only provides food security but also ensure livelihood security of 62 percent population of the country. However, agriculture is prone to existing climate variability and is further aggravated due to impacts of climate change. Changing climate increases the frequency of extreme events such as droughts and floods, delayed monsoon onset, intermittent dry spells and heat waves within the growing period. The impact of these events is felt by farmers differently based upon their socio-economic status. Regular occurrence of flood causes severe crop damages, sand casting and crop lodging which shattered the condition of farmers. To mitigate

this, farmers find it necessary to adapt and adopt new technologies to maintain economic, environmental and social sustainability.

Currently, India is facing a challenge of producing adequate food from shrinking natural resource base for the ever-increasing population. Intensification of agricultural activities through enhanced productivity and efficient use of resources are the option to available as competition for land and water is increasing from non-farm sectors. In other words, more production is needed with reduced natural resources under a variable climate. India also needs to take steps towards a carbon and energy efficient economy. All this calls for a Climate Resilient Agriculture (CRA) leading to sustainable food security through integration of innovations, technologies, efficient resource use, sound public policies, establishment of new institutions, and development of infrastructure.

MATERIALS AND METHODS

Climate change and global warming impacts all sectors of human life. Agriculture is particularly vulnerable to it. Higher temperatures tend to reduce yields of many crops; and encourage proliferation of weeds and pests. Although yield increases in some crops and other positive benefits have been noted in some regions of the world, the overall impact of climate change on agriculture is likely to be negative. Climate change will have a negative effect on yields of irrigated crops across regions, both due to increase in temperature and changes in availability of water. Rain fed agriculture will be primarily impacted due to rainfall variability and reduction in number of rainy days (Venkateswarlu and Shanker, 2012). Climate change causes hike of inputs cost as well as low yield of crops, meat and milk. Climate change disruption in agriculture and allied sectors and wellbeing of farm families. Impacts will be global, but much of the damage will be in developing countries, where, 11 per cent of arable land could be affected by climate change, including a reduction of about 16 per cent of agricultural GDP.

National Initiative on Climate Resilient Agriculture is one of the pilot project launched by Indian Council of Agricultural Research (ICAR), New Delhi during 2010-11, that correlate the climate variability and its impact on agricultural process and too aims at development in agricultural strategies based on variability of temperature, humidity, dry land and other adverse condition. National Innovations on Climate Resilient Agriculture (NICRA) is the brain child of Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad. It is a network project of Indian Council of Agriculture Research (ICAR) implemented in 100 vulnerable districts across the country. The project was implemented by Krishi Vigyan Kendras (KVKs) in different agro-climatic zones. Odisha is one of the vulnerable state of India.

Over the years, the climate variability has increased significantly across the state which is now threat for land based livelihood and farm resources. Kendrapara, Subarnapur, Ganjam and Jharsuguda districts are selected for piloting the NICRA project in Odisha. But, Kendrapara and Subarnapur districts are well known for its extreme events of environmental hazards like cyclone, flood, drought and the study is carried out in two vulnerable districts. To a greater extent, the Kendrapara (Flood Prone) and Subarnapur (Drought Prone) districts are reeling under climatologically distress condition. This refers to the susceptibility of the farmers and farm dependent communities to recurrent flood, cyclone, drought, erratic rainfall, soil moisture stress, water logging etc. resulting in crop failures thereby severely impacting the lives of agricultural communities, medium and small farmers and agricultural labourers. The most affected are the poorest of the poor and specially women and children.

The main objectives of NICRA are to piloting the climate resilient technologies related to natural resource management, agriculture, horticulture, livestock, fishery and related interventions in the farmers field. Time to time farmers are trained on various proven agricultural and allied technologies under capacity building programme. Proven technologies are popularised through demonstration trials in farmer's field and documented the process. The broad areas of climate resilient technologies are included construction of new WHS or renovation of water bodies for life saving irrigation, water saving technologies, soil testing, soil reclamation, better land husbandry practices, summer ploughing/summer deep ploughing, zero tillage, integrated crop management practices, drought & fold tolerant varieties, integrated farming system, fodder cultivation, custom hiring centre, seed bank, fodder bank and other income generating activities for the vulnerable community. After demonstration of short and long term interventions, farmer's response are the main concern of climate change adaptation and mitigation. The project has four components: the first one is strategic research on adaptation and mitigation followed by location specific technology demonstration on farmer's field, capacity building of project stakeholders and bridge up the research gaps.

The project is working on four modules to address the climate vulnerabilities through suitable interventions in project villages. The first module - **Natural Resources** emphasises on incorporation of crop residues in soil instead of burning, green and brown manuring, harvesting and recycling of water for supplemental irrigation, mulching, water saving technologies, improved drainage system in flood prone areas, conservation tillage and artificial ground water recharge. Similarly, the second module - **Crop Production** underlines on drought or flood tolerant varieties, variation in planting dates to avoid heat, cold and moisture stress condition, water saving crop production technologies included System of Rice Intensification, System of Mustard Intensification, System of Sugarcane Intensification, direct seeding, aerobic rice cultivation, rice-fish farming, community nurseries to avoid delay monsoon, frost management in horticulture through fumigation, intercropping, integrated farming, custom hiring centers of farm machinery for timely completion of farm operations and integrated crop management practices. Module three – **Livestock & Fisheries** accentuates on breed improvement of big and small ruminants, augmentation of fodder production through improved planting material, improved fodder/feed storage methods, fodder enrichment, fodder bank, prophylaxis, improvement in shelters for reducing heat stress in livestock, management of fish ponds/tanks during water scarcity and excess water and promotion of livestock as such as a climate change adaptation strategy. The last and fourth module - **Institutional Interventions** highlights on strengthening existing and new institutions related to community seed bank, fodder bank, custom hiring centre, commodity groups, collective marketing group, introduction of weather index based insurance and climate literacy through a village weather station will be part of this module.

RESULTS AND DISCUSSIONS

All climate resilient location specific and need based technologies are demonstrated in two KVK-NICRA villages in Subarnapur and Kendrapara district since 2011. Out of 31 climate resilient technological interventions, 21 are accepted by the farming communities in two respective villages. In drought situation of Subarnapur district, *Sahbhagidhan* was demonstrated and yield attributes was increased up to 25.13 percent and having drought tolerant characters. Similarly, in flood situation of Kendrapara district, Swarna Sub-1 demonstrated and the yield increased up to 32 percent. The variety is having 14 days flood tolerant ability and survive up to 14 days without any physical injury. While in SRI method of cultivation, paddy variety Lalat & Konark and use of cono weeder for weeding brought out 32.16 per cent higher yield over local variety in rice. Intervention aimed at location specific intercropping systems, when demonstrated in farmers'

field, pronounced achievement was reported from groundnut and sunflower, arhar and groundnut intercropping system with an enhancement in yield by 137.17 per cent. Similarly vegetables like brinjal, pointed gourd, chilli yield increased up to 30 per cent and 20 per cent yield of pulses was reported by Krishi Vigyan Kendra (KVK), Subarnapur and KVK, Kendrapara of Odisha (Annual Report 2012, 2013 & 2014). With location specific disease and pest management in paddy and pulses 43.27 per cent loss in production was eliminated. Composite fish farming is way of managing fish ponds or tanks during water scarcity or surplus water during on and off season to enhance fish production up 125 percent. After construction of water harvesting structures, farm pond and renovation of well, check dam and in-situ moisture conservation measures, protection of forest and plantation interventions increases water table up to 4 ft. in well in upper, middle and lower ridges. Most of the farmers and farm women were participated in the training programmes like SRI, SMI, SSI, Organic farming, on/off season vegetable cultivation, mushroom cultivation in both the villages. Small and marginal farmers are mainly using the village level NICRA custom hiring centre of farm implements during cultivation of crops and nominal amount deposited in the NICRA account for post project management and repair the implements. Provision of farm machineries and agri. implements assured timely planting and higher yield. Seed bank and fodder bank in NICRA villages are helping farmers to mitigate their seed and fodder demand. Most of the activities are undertaken under NICRA seem to be promising to avoid climatic traces and farmers friendly. The benefits of the climate resilient technologies need to be circulated wide spectrum among the farming communities across the district-state and country.

CONCLUSIONS

Monsoon in India has become increasingly unpredicted and erratic in recent times. The number of intense rainfall events together with reduced number of rainy days has been noted during the latter half of last 50 years. Thus, risks of drought and floods have increased in the country's kharif rice crop. Climate change affects agriculture both directly and indirectly in different form. The type and magnitude of impact will vary depending on the degree of change in climate, geographical region and type of production system. Assessment of impact of climate change is carried out through controlled experimentation and simulation modelling. Climate change is one of a variety of threats to food security across the world. Interventions are to be designed based on weather pattern and suitability to the agro-ecosystem to upsurge food security. The adoption of climate resilient technologies are stated below:

Table 1: Adoption of Climate Resilient Technologies in Two NICRA Adopted Villages of Subarnapur and Kendrapara District in Odisha

Sl. No	Technologies Used by Farmers	Percentage(%) of Adoption of Technologies By Farmers in Drought Situation (Badmal Village)	Percentage(%) of Adoption of Technologies By Farmers in Flood Situation (Krushnadaspur Village)	Average Farmers Adopted the Climate Resilient Technologies
1	Summer ploughing (Every Year)	78	76	77
2	Deep Summer ploughing (In every 3 years)	54	46	50
3	Zero Tillage	12	18	15
4	Soil sample collection & testing	62	58	60
5	Reclamation of soil by using Lime/paper mill/Gypsum sludge	58	53	55.5
6	Green manuring in lowland paddy	32	25	28.5
7	Soil test based fertiliser application	45	42	43.5
8	Seed treatment (Crops & vegetables)	77	65	71

Sl. No	Technologies Used by Farmers	Percentage(%) of Adoption of Technologies By Farmers in Drought Situation (Badmal Village)	Percentage(%) of Adoption of Technologies By Farmers in Flood Situation (Krushnadaspur Village)	Average Farmers Adopted the Climate Resilient Technologies
Table 1: Contd.,				
9	Use of flood tolerant/drought tolerant varieties	80	86	83
10	Early/Delay in sowing of seed	34	67	50.5
11	Raising of community nursery at 15 days interval during kharif	43	32	37.5
12	Practised soil & water conservation measures	74	58	66
13	Renovation/Construction of WHS/FP/Dug well for live saving irrigation & Integrated Farming System	71	72	71.5
14	In-situ moisture conservation measures	76	72	74
15	Paira cropping	32	56	44
16	Follow the INM/IPM/IDM/ICM	78	76	77
17	Low use of pesticides	63	67	65
18	Judicious use of water in crops	59	53	56
19	Soil solarisation	23	16	19.5
20	Use of Vermicompost	42	38	40
21	Use of Azolla	28	12	20
22	Drip Irrigation	4	2	3
23	Sprinkler	8	7	7.5
24	Seed Bank	69	62	65.5
25	Fodder Bank	57	45	51
26	Custom Hiring Centre	78	82	80
27	Miscellaneous Tree Plantation	68	65	66.5
28	Fruit Tree Plantation	73	75	74
29	Reduce in burning of crop residues	54	51	52.5
30	Inter cropping	67	65	66
31	Integrated Farming System	72	65	68.5

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